DRAFT ETAAC Report– Renewable Energy Section

Renewable energy will play a key role in meeting CARB's 2020 GHG reduction goals based on California's goal of achieving 33% of electricity from renewable resources by 2020¹ and for putting the state on a trajectory for longer-term GHG reductions. Technological development is also critical for meeting AB32's goal of serving as a model for other countries to power economic development along a low and zero carbon pathway. Advanced technology renewable resources also have an important role to play in meeting California's air quality challenges – especially in regions where identified air pollution control technologies fall short of air quality goals.

Developing renewable energy in California also offers important economic opportunities. Over two-thirds of venture capital invested in California in 2008 went into renewable energy, primarily solar, bringing important job-creation benefits. Locally developed renewable energy can replace fossil fuel imports with in-state natural resources, and a number of reports have found that it provides significantly more jobs per megwatt than fossil technologies². In addition, renewable energy is already a large international market – for instance the global market for solar and geothermal technologies is estimated at nearly \$700 billion annually and renewables are a leading sector for high market growth potential (UK BEER report).

This chapter addresses the challenges and opportunities for the development of advanced technologies in two parts. The first part addresses issues that are faced by a number of different technologies. These issues include distribution where and when energy is needed, and demonstration finance. The second part recognizes that individual technologies also face technology-specific issues, and addresses issues for solar energy, geothermal, biomass, and wind.

I. Technology-Agnostic Issues

a. Grid Expansion

Transmission Efforts are Key to Renewable Energy Production Goals

There is broad recognition today that the nation's interstate transmission infrastructure needs to be expanded to accommodate existing and new sources of renewable energy, which tend to be located at considerable distance from population centers. Simply put, without a more robust bulk transmission grid, the economic, environmental and energy security benefits that would come from tapping the country's immense renewable energy potential will not be captured, potentially jeopardizing our ability to successfully meet the country's mounting energy and environmental challenges. For more details, please see chapter 5 of the original ETAAC report.

¹ The ARB's Scoping Plan shows that a 33% RPS could contribute up to 21.3 MMT out of 176 MMT of CO2e reduction

² for instance, Deloitte report for US DOE, http://www.geo-energy.org/publications/reports/Geothermal_Energy_and_Jobs_Issue_Brief.pdf

Current transmission lines are insufficient for the nation's growing renewable energy needs, Expanding renewable energy production, particularly on the scale envisioned under proposed climate change and renewable electricity standard legislation, hinges on a renewed and significant investment in our country's bulk electric transmission infrastructure. A key to accomplishing this vision is updating the standard policy framework governing interstate transmission financing and cost recovery and creating a regulatory environment for transmission and related enabling technology investments that enhances development and utilization of location-constrained renewable resources. In addition, federal stimulus legislation under the American Recovery and Reinvestment Act will provide additional funding to support innovative transmission efforts.

This transmission challenge is particularly acute for prospective project sponsors looking to build so-called green interstate transmission superhighways in wholesale bilateral markets not served by regional transmission organizations, an area that includes the entire interior West. These projects have the ability to be designed and built specifically to maximize access to cost effective out of state renewable energy resources more economically, while at the same time minimizing land use and wildlife impacts.

Active California and regional transmission planning processes reflect these priorities in, where for instance thousands of megawatts of undeveloped geothermal reserves have been identified that can help California and Nevada meet their ambitious renewable portfolio standard goals with the build-out of major new geothermal resources to achieve their power production goals and to maintain grid reliability.

b. Distribution System Issues

The existing electric distribution system uses a top-down, one-way hierarchy, with interruption devices placed throughout the feeder. Any energy that is generated must be used up by other loads on the same feeder. The injection of large amounts of distributed generation such as photovoltaic solar onto the distribution feeders raises a number of issues. Specifically,

- Voltage regulation: The feeders are not designed to accommodate injection of onoff energy sources. A high concentration of distributed generation from intermittent resources could cause voltage sags if the generation drops off suddenly (e.g. from cloud cover over PV systems). Conversely, the lines could become over-energized if the amount of generation is much greater than available load on the system. The voltage distortions created by PVs as they come on line and off during operation could cause the line voltage to exceed acceptable limits.
- Protection coordination: The interrupting devices installed on distribution feeders are designed to isolate affected areas during an event. As PV units are added to the distribution system, the adequacy of the protection devices in the circuit must be reviewed and/or modified as needed (e.g. increasing fuse size). While the number of distributed PV installations is low now, the California Solar Initiative calls for the installation of 3000 MW of PV by 2016. As the penetration of PV increases, the amount of protection coordination will also increase, which could add considerable burden to distribution planning in terms of both time and cost.

Anti-islanding: Distributed generation units on the feeders are equipped with anti-islanding devices. This means that during fault events when power is shut off to a feeder circuit, any generating equipment on the feeder must also disconnect to prevent power flow to the line. For large generators, direct transfer trips are installed. In the case of PV, contacts in the inverter are designed to automatically open when "bumps" in line frequency –such as those that occur when the breaker on the feeder line trips—are detected, and reclose after a timed delay (generally 5 minutes) if there is no actual power outage. This also means that PV systems could and indeed do trip offline at other times when frequency fluctuations occur on the line for other reasons. A large amount of distributed generation coming on and off the grid could cause PVs in the same or nearby circuits to constantly trip off.

Advanced Technology Solutions: Smart Grid and Smart Inverters

Various Smart Grid-related technology research and developments are underway within the State and nationally. Among these, smart inverters may have the potential to enable higher penetration of PVs and provide a number of services to optimize grid operation such as:

- Enabling installed PVs to act as a grid resource to provide ancillary service;
- Communicating with the grid to integrate distributed generation and storage facilities for example, sending the power generated to energy storage devices or charging plug-in EVs at specified times;
- Allowing PV generation to remain connected during some grid disturbances, while meeting safety operation requirements;
- Providing voltage regulation by injecting into or absorbing reactive power from the grid. This can help prevent voltage disturbances that in benign cases cause dimming of lights or in worse cases, computer crashes or damage to equipment.

However, current interconnection standards were developed for current capabilities and penetration levels, and therefore prohibit inverters from providing reactive power or anything that impacts line voltage. As technological capabilities improve and penetration levels increase, standards will need to change at the national level in order for the grid to use smart inverters for voltage support (IEEE 1547 and UL inverter standards). In addition, there is no communication capability in inverters sold today, although they can be manufactured to include communication capability. California will be the first market to reach the PV penetration level that would make smart inverters useful. This will provide the potential to transform the market, but the policy framework to enable technology development and commercialization must be developed.

DOE's Solar Energy Grid Integration Systems (SEGIS) program is studying and supporting the development of smart inverters. However, the technology development is at R&D phase. Additional support will be needed at each technology development phase, from lab testing to field demonstration, to eventual commercialization.

As described above, these advanced technologies solutions are less well understood (than Home Area Network or HAN, for example, described in the Energy Efficiency section) in terms of how they should be applied and what value they create. At this early stage in

the technology lifecycle, state and federal governments need to fund/support efforts that seek to demonstrate the applicability and value of these technologies to a broad set of industry stakeholders (e.g., utilities, vendors). Furthermore, similar to the situation with HAN, every effort must be made to support the development of standards that will enable interoperability and an efficient market for these technologies. By taking this approach, CA not only benefits from the deployment of advanced technology solutions but positions itself as a fertile ground for smart grid innovation and advancement.

c. Renewable Energy Storage

The ETAAC report emphasized the importance of energy storage as an enabling factor for putting more renewables online. The need for storage to meet California's aggressive renewables goals is being more widely understood. The federal government has also recognized this need. The Department of Energy recently issued a Funding Opportunity Announcement under the American Recovery and Reinvestment Act (ARRA) to solicit proposals for advanced energy storage. DOE noted that "Electric grid operators can utilize electricity storage devices to manage the amount of power required to supply customers at times when the need is greatest, which is during peak load. Electricity storage devices can also help make renewable energy resources, whose power output cannot be controlled by grid operators, more manageable. They can also balance microgrids to achieve a good match between generation and load. Storage devices can provide frequency regulation to maintain the balance between the network's load and power generated, increase asset utilization of both renewables and electric systems, defer T&D investments, and achieve a more reliable power supply for high tech industrial facilities."

DOE's proposed funding of up to \$200 million in energy storage demonstration projects is an important first step in getting more storage on the utility grid to allow the integration of more low-carbon resources. However, there are non-technology challenges that will still need to be overcome.

The original ETAAC report noted the importance of energy storage to meet GHG reduction goals by helping integrate larger quantities of renewable energy from technologies that are not dispatchable, i.e. cannot be turned on & off to match demand. The report also identified the potential for synergies between electric vehicles as a potential energy storage solutions, as first generation vehicles can accept off-peak renewables if the timing for charging is right. First generation vehicles are not expected to emphasize storing off-peak energy to export back onto the grid, which could occur in future generations. Energy storage can also provide many different beneficial services, including some combination of: 1) interruption avoidance, 2) outage avoidance, 3) congestion relief, 4) transmission upgrade deferral, 5) distribution upgrade deferral, 6) generation deferral, 7) time-of-day price arbitrage, 8) peak demand reduction, 9) renewables firming, and 10) several forms of ancillary generation service. This wealth of opportunities presents two challenges: "How do you optimize between the benefits (e.g., how much ancillary services support can be provided while providing other services)?" and "How should the cost of those services be recovered?"

The latter challenge results because there may be four different recipients of value: the transmission ratepayer class (FERC recovery), the distribution ratepayer class (CPUC recovery), the generation market (CAISO recovery or energy market recovery), and/or individual customers (services market recovery). Allocating costs between some combinations of the four possible "markets" is not an easy or common task.

d. Demonstration Finance Strategies

The challenge of financing unproven technologies at scale is a large and growing component of the clean energy transition. In brief, and as discussed in the ETAAC report adopted in February of 2008, the issue arises due to a structural weakness in the clean energy finance industry: risk equity, in the form of venture capital, finances technology development, while debt markets will support proven technologies in achieving infrastructure scale. The crucial intermediate step, the provision of funding for a maturing but not fully-proven technology to demonstrate its viability in real-world settings, is missing from the financial marketplace. As clean energy technologies mature, the absence of this financial support will only become more detrimental.

The existence of this problem is well known, and potential solutions are emerging (ETAAC report, E2 Carbon Trust report, pending CalCEF and CEG reports). California has the opportunity to combine a number of these potential solutions and integrate them with existing clean energy procurement mechanisms, in particular the well-developed policy tools used in the state's Renewable Portfolio Standard (RPS) program. What follows is a brief description of some of these potential solutions, presented in a form that attempts to locate each option along the spectrum of technology development from early-stage concept to proven, scalable resources.

Framing Issue – an Emerging Technologies Plan. California's RPS program does not presently include a structured plan for the consideration of interesting innovations that reasonably balances the public interest in clean energy deployment and the need for ratepayer protections against downside risk. Absent this plan, regulators and utilities must consider each emerging technology on a standalone basis, with little means for determining the potential programmatic benefits of sponsoring one experiment over another. Moreover, there is little if any opportunity to share the benefits of project success with the ratepayers that undertake these necessary financing risks. Formation of a statewide plan for the integration of emerging technologies with RPS procurement may encourage more strategic choices of demonstration opportunities, and paired with a shared earnings approach, as discussed below, can promote an equitable distribution of financial benefits.

Step Two – Identification of Funding Source and Scale. Given the generally higher cost of emerging renewable technologies, it may be reasonable to consider a "regulatory budget" to support a demonstration finance strategy within the RPS program, which could take the following form:

a. Integration with the CEC PIER program for the funding of emerging technologies. The two programmatic efforts of RPS and PIER have not been

- sufficiently integrated in the past, potentially wasting a useful collaboration opportunity between the two agencies.
- b. Determining a total above-market cost threshold that will limit upward pressure on rates. With or without the financial support of the CEC PIER program, there may be extra costs that ratepayers will absorb through such mechanisms as an above-MPR Power Purchase Agreement authorized to spur deployment of a new technology. An annual or planning-cycle cap could be imposed on the program such that rate pressure is kept within a tolerable range, and demonstration projects could be sized to encourage the development of the most technologies before the threshold is hit. *ETAAC* is currently considering how this potential proposal could be implemented

Step Three – Physical Location of Demonstration Facilities. A core component of the demonstration challenge is the inability of new technologies to be sited and tested in real-world operating conditions. Performance under these conditions, including the inevitable failures and the attendant systems repair and learning that occurs, must be closely monitored over extended periods in order to provide project lenders sufficient data against which to lend. It is unlikely, however that a single demonstration facility will be optimal for the range of potential renewable technologies; a potential solution might be the following:

a. Set aside a dedicated portion of existing or planned resource areas for specific technology types – e.g. a wind sub-park in the Tehachapi or solar thermal in the Mojave, taking advantage of existing resource assessments, transmission interconnections, and other high-cost logistical issues that demonstration-stage companies are unlikely to be able to address.

Step Four – Streamlining Integration of Demonstration Technologies in the RPS Program. The establishment of dedicated demonstration facilities helps to address a major integration issue for small projects. Further streamlining initiatives could include:

- a. Specified dual-track procurement within the RPS, with a demonstration-specific track drawing in the technologies that will populate the reserved areas at technology-specific locations on the grid. ETAAC is currently considering how this potential proposal could be implemented and what scope of project would apply.
- b. Ensuring that land use and permitting issues are addressed at the demonstration facility level, as opposed to being placed on the technology provider solely, creating a true "plug and play" environment for emerging technologies. This potentially mirrors the larger scale strategy under development for proven technologies within the RETI process.
- c. Locating the necessary performance monitoring data at the demonstration facility, to assess technology viability in preparation for scale-up.
- d. In appropriate, establishing a milestone-driven process for the award of a full-fledged RPS PPA to a demonstration technology that proves its merit. Milestones could be attached to tiered increases in the size of the PPA, with expected declines in contracted MWh costs as technologies improve and scale. ETAAC is currently considering how this potential proposal could be implemented.

Step Five – Dedicating Energy Program Staff to Coordinating Engagement with Federal Funding Opportunities. Multiple federal programs exist that can aid in the progression of developing technologies, principally including direct grants, direct loans, and indirect loan guarantees. To best avail California of these resources, reduce the financial burden on ratepayers supporting emerging technology, and aid technology developers in efficiently accessing these funds, the state could consider the following:

a. Dedicate staff to coordinating with federal agencies (DOE and Treasury) with purview over the relevant funding programs, to educate federal agencies about California's demonstration program and potentially streamline the awarding of funds to worthy demonstration technologies. For example, a loan guarantee award to a technology maturing through the demonstration program could be made contingent upon the same set of milestones, described above, that could trigger the execution of a larger RPS PPA.

Step Six – Sharing Financial Benefits with Utility Ratepayers. While it can be bounded via the planning and budgeting functions described above, ratepayer exposure to financial risk is potentially considerable under a demonstration finance program. The framework of such a shared-benefit structure is understood, and could potentially include the following:

a. Create a royalty payment mechanism within RPS PPAs that are executed at above-market costs, with royalties paid into a utility balancing account when projects are developed and operational. These funds could then be credited to ratepayers to reduce rate burdens, recycled into future iterations of the demonstration finance program, or both.

Conclusion. This six-step outline with associated policy recommendations only begins to describe the range of options available to California in addressing this important problem. It is intended to spur discussion involving ETAAC and interested stakeholders as we engage solutions to the problems identified in our previous undertakings.

II. **Technology-specific Issues** (CPUC 33% RPS Report categories)

a. **PV** – role of costs, technology improvements in feasibility of 33% target
The CPUC 33% RPS Report models PV penetration that ranged from 3000 MW in the
33% RPS Reference Case (current procurement practice) to 15,000 MW in the High DG
Case. According to the report, the former would require increasing worldwide installed
solar PV by about 15% relative to 2008 levels, and the latter would require a doubling of
global solar PV capacity in California over the next 10 years, in addition to strong solar
PV demand in other countries. The risks associated with relying on technologies untested
at this scale may include, at best, project delays, or at worst, the possibility that some of
the new technologies never reach commercialization. On the up side, technology
breakthroughs could occur, though they would need to occur almost immediately to meet
the 2020 timeline. California has major strengths in PV solar technology development,
such as leadership in venture capital investment, public and private research, and

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interconnections with the semi-conductor industry – providing opportunities for economic development as well. The State needs to make a coordinated and concerted effort to remove barriers to project development and implementation and support commercialization of emerging technologies.

Photovoltaic technology has made progress on several fronts since the ETAAC report was written. New ways of making thin film PV materials have moved from prototypes to production lines, increasing competition for industry-leading silicon. The current thin film leader announced that it had broken the \$1/Watt cell cost barrier at the end of 2008 only to have a competitor using the same material open a new factory a few months later with a claimed ability to achieve even lower costs.

The cost progress with the greatest impact occurred within the silicon market. Four factors contributed to the lowest silicon cell cost in history. Silicon shortages in the last few years created the market signal to build new silicon production factories, which went into operation recently. The global recession has had some effect on demand for PV. The third factor affecting silicon cell costs was due to a policy change in Spain. The Spanish government reviewed the last few years' activity in and costs of its feed-in tariff and decided to put in place a cap that severely reduced activity in 2009 while lowering FiT prices in an attempt to reduce the "tariff deficit" that had forced utilities to sell electricity under cost, at an estimated loss of €4.85 billion in 2008. As the industry had planned on the continuation of a 1-2 GW market, the cap effectively created an instant excess of 1-2 GW of PV modules. The fourth factor in the silicon PV market is the growth of the Chinese solar industry. The Chinese solar industry has grown quickly. In 2008, 5 of the top 10 PV suppliers in the world were from China or Taiwan. China now has a 40% share of the world's PV manufacturing capability.

These cell cost improvements have not produced significantly lower installed system prices, except in a few large-scale applications. One factor affecting how little system installation costs have changed is that labor and other non-module costs are a major part of system costs and they have not seen substantial cost reductions. Other economic factors may also be involved.

IC Insights, a researcher specializing in the semiconductor sector, issued a report in July 2009 that summarized the net effect of the above events. The report says that global PV production capacity in 2009 will grow 32% while installations worldwide will decline 22% on a MW basis. As a result, panel and module costs will be reduced by 28%. However, installed system prices will only fall by 9%.

The California grid now has nearly 50,000 sites with distributed solar PV with nameplate capacity of more than 515 MW. However, these MW of distributed PV have made zero contribution to accomplishing California's RPS goals and the high expected future growth (to more than 3,000 MW) may never have any meaningful impact on meeting the 33% RPS goal of AB 32 unless Renewable Energy Credit (REC) restrictions are lifted. Under current rules, the REC belongs to the site owner, but RECs are not eligible under current RPS rules, so the site owners have not been able to contribute to RPS. Eligibility

of RECs has been the subject of legislative and regulatory proceedings, but much of the discussion has been around limiting RECs to a small percentage of the overall RPS portfolio.

b. Solar Thermal

Progress on the concentrating solar thermal front has occurred, for instance there are a number of demonstration projects that have obtained or applied for a license from the California Energy Commission (CEC), but it has not been as obvious nor as widely, systematically, and transparently tracked as PV progress. Individual companies have publicized their technology developments, but most cost information is still proprietary. Applications to the CEC confirm other studies showing that solar thermal electric generation provides at least twice the in-state jobs of fossil thermal generation.

The challenges that apply more universally to concentrating solar thermal technologies have been more apparent and widely discussed. Three challenges, beyond individual technologies, slow the deployment of concentrating solar thermal power projects. Of the two solar technologies, only concentrating solar thermal needs to address the need for cooling the working fluid run through a turbine to produce electricity. Many projects have addressed the issue by designing dry-cooled or minimal-water cooled plants. This is a particularly difficult issue in the desert where the high ambient temperatures make dry cooling inefficient and costly. The other two issues slowing concentrating solar thermal are equally applicable to utility-scale PV projects. The best solar resources and the amount of land needed to site a project (5-10 acres per MW) both imply the need to locate away from population centers, necessitating major transmission expansions. Both of those issues also imply another challenge – the substantial footprint requirement and the need for transmission both create environmental impacts. There needs to be a mechanism to mitigate environmental impacts while still allowing a level of development.

c. Biomass -

1. Biomethanation

The siting and permitting of biomass power plants are becoming increasingly difficult due to air quality regulation. Converting biomass and biogas to pipeline quality natural gas (biomethanation) allows the biomethane to be transported to and burned in highly efficient natural gas combined cycled power plants with state of the art emissions control technologies. This turns the biomass feedstock into a flexible resource that can be stored and dispatched as needed. Biomethane is also an effective way to increase renewable generation by displacing natural gas at existing plants. There are two technology options for biomethanation: biologic conversion through anaerobic digestion and chemical processes such as pyrolysis and gasification.

Anaerobic Digestion: While anaerobic digestion technology is not new, regulatory and permitting hurdles abound that limit the economic and project feasibility of biomethane projects. Research is on-going to improve digester efficiency as well as the upgrading process. Technologies to increase methane yield or reduce residence time include co-digestion of various feedstock, e.g. food waste, and the selection of optimal mix of

bacteria, as well as improvements in digester design and controls. These technology improvements need in-field demonstration and technology validation before they can be scaled up. More importantly, the State needs to streamline and expedite the permitting process.

Gasification: Anaerobic digestion is suitable for wet feedstock such as animal and food waste and sewage sludge. Gasification, on the hand, applies to dry, lignin-rich biomass such as forest residues, straw and orchard prunings, and major portions of the MSW stream. Gasification is a thermochemical process that converts biomass into a hydrogen and carbon monoxide rich gas, which can then be converted to methane (bio-synthetic natural gas or Bio-SNG) through the use of a catalyst. While biomass gasification for power production has been under development for some time, it has yet to reach commercial success. There are small scale biomass gasifier-generators being deployed for power production; however, the same air regulation and other onsite generation constraints exist. Biomass gasification combined with biomethanation is an emerging field, and as such, many of the same barriers to entry apply —in particular, high capital cost and the need for demonstration financing.

Pyrolysis: Pyrolysis refers to the thermal decomposition of biomass in the absence of oxygen to produce syngas or bio-oils that can be used for heat and power production or conversion to liquid fuels or industrial chemicals. As with gasification, the pyrolysis process is suitable for agricultural or forestry residue; however, pyrolysis operates at a lower temperature than gasification and produces lower bioenergy output. However, pyrolysis produces biochar as a residue, which has value as a soil amendment to increase soil productivity and may have carbon sequestration potential, although additional research is needed in this area.

2. Torrefaction/Pelletization

One technology solution to address the biomass transport and storage issue is to pelletize woody biomass – drying, shredding and compressing the biomass into small cylindars or pellets which can then be transported to biomass power plants and burned as fuel. Wood pellets can be made from sawdust or soft wood grown in industrial plantations. This practice is generally used in Europe and the eastern US.

A newer technology solution involves torrefaction – a process of heating woody biomass in an oxygen-free environment to a mild temperature (200-300C) and then compressing the "roasted" product into pellet form. The torrefaction process increases the energy density of the biomass to that similar to coal and also makes it brittle. This means that the torrefied pellets – also called bio pellets or biocoal – are ideal for co-firing in coal plants. Depending on the amount used, co-firing of biocoal has the potential to bring the GHG emissions of coal plants down significantly.

3. Microbial Fuel Cells

Microbial fuel cells are biologic fuel cells that generate electricity by harvesting the electrons produced by bacteria during the digestion of organic feedstock such as wastewater or sludge. They serve the dual benefit of clean power production and

wastewater treatment. As existing tariff prohibits the injection of biogas from wastewater treatment plants and landfill gas into utility gas pipelines, microbial fuel cells provide an ideal solution where onsite generation is not feasible, e.g. due to air emissions regulations. The development of microbial fuel cells is at an early stage and will require demonstration support as the technology further advances.

4. Dedicated Energy Crops

Dedicated energy crops provide one solution to dispersed and inconsistent biomass supply. Some crops can be purposely selected to have certain properties such as the ability to grow on marginal land, withstand drought, and produce high yield. Such crops help improve project economics by requiring less land and lowering costs associated with harvesting and transporting the feedstock, thus making dedicated energy crops a viable source for biopower.

Additionally, biomass crops can be used to for remediation of degraded or impaired land. For example, biomass crops can be selected to absorb selenium and grown in areas where excess selenium is an issue. Finally, some crops may provide carbon sequestration through their below-ground root mass. For example, switchgrass has deep root systems extending as deep as three meters as well as the ability to replace dying roots with new, live roots. At least one study has shown some increase in soil organic carbon in soils where switchgrass has been grown as a dedicated energy crop after 5 years³, although the results across sites are inconsistent and additional field-based assessment are needed to determine the net carbon sequestration effects.

d. Wind-

ETAAC Wind Chapter

Wind energy is an integral part of California's renewable resources supplying about XX MHw of energy in 2007. California was an early leader in incorporating wind resources as a part of the energy mix, with contracts, tax policies and other incentives to encourage wind development. California was the primary wind market for many years. The California Public Utilities Commission estimates that between 7500 MWs and 9500 MWs of new wind will be need to meet California's 33% RPS goals.

Today, California's wind capacity ranks third behind Texas and Iowa. While there is continued interest in building new wind generation, as well as, repowering existing sites with newer technology, wind faces several infrastructure and environmental challenges. These include:

- Transmission to wind resource areas;
- Integration of intermittent wind into the grid;
- Avian impacts.

These issues apply to both existing technologies, as well as newer wind technologies. The CARB Scoping Plan calls for a 33% Renewable Portfolio Standard. Wind energy

³ M.A.Liebig, M.R. Schmer, K.P.Vogel, R.B. Mitchell, "Soil Carbon Storage by Switchgass Grown for Bioenergy", 2008

resources will be an important component in meeting this RPS policy. Therefore, it is essential that these challenges be expeditiously addressed.

Transmission:

Wind is a site specific resource that is often distant from load centers and lacking sufficient transmission to get energy to market. Nationally, lack of adequate transmission is a major obstacle for developing some of the prime wind resource areas. In California, transmission planning, siting and construction is underway which will allow the development on new wind resources.

The first segment of the Tehachapi Transmission line is current being constructed by Southern California Edison. When fully built out, these new transmission facilities will access up to 4000 MWs of new wind generation.

San Diego Gas and Electric has approval to construct the "Sunrise Transmission Line" connecting San Diego to resources to the east. There are significant opportunities for wind in southern San Diego County and Northern Baja California in Mexico. California has developed a stakeholder process known as the "Renewable Energy Transmission Initiative (RETI)" designed to identify new transmission needs and to create Competitive Renewable Energy Zones. This process has produced two reports with specific mapping that is useful in identifying key areas for renewable energy development and related transmission. (Foot note). This process is consistent with the recommendations contained in the ETAAC Report.

Transmission planning is a dynamic process where location of new generation and patterns of load growth affect the need to add new transmission facilities. This will continue to be a process that will significantly affect the wind industry as it grows into new geographical areas more remote from load centers.

The key barriers associated with transmission are environmental siting concerns raised as specific projects are proposed. Conflicting land use and environmental goals are issues that policy makers need to address.

Grid Integration:

Wind energy is an intermittent resource that is dependent upon whether the wind is blowing. This is related to meteorological conditions which can change seasonally or even over the course of the day. Therefore, integrating wind generation into the grid is important issue necessary to fully develop potential wind energy resources. The grid operators, also known as "balancing authorities are responsible for keeping the transmission grid balanced in real time at 60 hertz cycle. This is a very dynamic process as load fluctuates throughout a day with generation dispatched to follow it. The "integration" challenge for wind is matching its availability to demand. There are several strategies for addressing this issue.

Operationally, wind availability is not a random event. Wind resource areas have been well studied as to wind patterns so that wind availability is generally understood. Sophisticated software predicting wind is available to grid operators for dispatch decision.

The larger the operating area of the grid operator the less significant the integration issue may be, because the wind resources will be geographically dispersed. Wind may not be available in one area, but is blowing hard in another. Managing intermittent resources over a larger geographical area with multiple grid operators may be an effective integration strategy.

Back-up generation is also available. The CAISO will dispatch fossil fuel plants and peakers, to meet the ramping needs of wind resources. The wind resources displace this fossil generation in other times of the day. However, it is important that electricity products in the form of ancillary services, are available to meet this growing need. Storage was identified in the ETAAC Report as an important game changing enabling technology which has significant impacts on the wind industry. Storage, utilizing batteries, compressed air, or pumped storage (hydro-electric), uses wind generation to charge batteries, compress air or pump water which can then be used by the grid operator at a later time.

PG&E recently announced a pump storage project in Kern County designed to store wind energy generated in the Tehachapi Wind Resource Area. The Compressed Air Energy Storage (CAES) project would have a 300 MW capacity with 10 hours of storage. PG&E proposes to use saline aquifers as storage media. Saline aquifers are abundant in California. If approved, this demonstration project may be an important advancement in energy storage. Southern California Edison has proposed using batteries in a demonstration project (More details to follow). AES, has recently added several new battery installations in Southern California and is looking for additional opportunities. Ultimately, the advent of hybrid and electric cars will provide a meaningful opportunity for utilizing renewable energy generation, in the form of wind, for transportation. This will require additional investments in new infrastructure integrating wind resources with individual vehicles.

These new storage technologies will present new planning, rate recovery and rate-making issues for the CPUC and publicly owned utilities in developing these resources. Similarly, these new technology may raise local land use and CEQA related issues. California will need to be proactive in ensuring that storage technologies are an integral part of the RPS.

Avian Issues

A California wind developer will generally spend three to six years to obtain a permit to build a wind project, and spend on the order of \$1 - \$3 million to conduct the required environmental studies and navigate the permitting process. Substantial research (at least \$5 million over three years) is needed to improve the efficiency and efficacy of the environmental study and permitting process.

In 2007, the Energy Commission and California Department of Fish and Game released California Guidelines for Reducing Impacts to Birds and Bats from Wind Energy Development (Guidelines) to provide recommended protocols for assessing and minimizing impacts from wind energy development to birds and bats. The Guidelines also recommended mitigation measures. In October 2008, the CEC released a *Roadmap* for PIER Research on Methods to Assess and Mitigate Impacts of Wind Energy Development on Birds and Bats in California (Roadmap). The Roadmap discusses the lack of scientific bases for many, if not most, of the recommendations that were made in the Guidelines and identified several short- and long-term research needs to determine the methods that are most effective in predicting fatalities at sites of various types. Absent this research, wind energy developers must comply with voluminous recommendations in the Guidelines while also conducting the studies that are necessary and appropriate for a particular site. The result is an inefficient, unduly expensive, and time-consuming process. Further, the *Guidelines* lack any structure for determining which studies should be conducted, to what extent, at any particular site. Such a framework should involve asking and answering questions like: What are we trying to determine with the data we are collecting? How much data is needed of what quality to be confident in the predicted mortality? Which sites need less study and which sites more? Developing such a framework should be rigorously tested with real data. The wind industry believes that a relatively modest research effort, aimed at ensuring the effectiveness and efficiency of study techniques in accurately predicting and mitigating avian/bat impacts, could significantly reduce both the time and expense of the permitting process, while improving environmental outcomes.

Wind has significant potential in meeting a part of the electrical needs in California and the west. Interstate transmission planning, storage and new technology will create further opportunities for wind development.

e. Geothermal Power - Update on Development and Barriers

Background

Geothermal power continues to be a growing and important part of the energy supply mix in the Western United States, as grid-connected geothermal power plants provide, baseload power today in California, Nevada, Utah, and Idaho with reliability of 90% or greater⁴. Geothermal energy produced 4.5% of California's electricity in 2007, producing 24 hours a day (although energy storage could also benefit this technology to the extent that it allows shifting off-peak electricity to peak periods of demand). Moreover, a recent study by researchers at Stern School of Business at New York University concludes that geothermal energy is on the verge of becoming a better investment than fossil fuel.⁵

⁴ http://www.westgov.org/wga/initiatives/cdeac/Geothermal-text.pdf

⁵ See Melissa A. Schilling and Melissa Esmundo, "Technology S-curves in Renewable Energy Alternatives: Analysis and Implications for Industry and Government," in *Energy Policy* 37 (2009) pp. 1767–1781.

In September 2008, the U.S. Geological Survey estimated that geothermal reservoirs in 13 states could produce upwards of 9,000 megawatts of electricity—as much as nine nuclear reactors. The actual potential of geothermal power may be much greater, thought, because scientists have never fully assessed the moderate-to-high-temperature resources that are available. The U.S. Geological Survey report suggests that it may be possible to generate an additional 30,000 megawatts of power from moderate-to-hot geothermal resources that have yet to be discovered. The Western Governor's Association found that adding new geothermal power capacity of 5,600 MW by 2015 could add nearly 10,000 jobs, and also generate about 36,000 person-years of construction and manufacturing business⁶.

Geothermal Development

Despite the lagging economy, interest in new geothermal power projects remains strong. The Geothermal Energy Association's (GEA) most recent industry update in March 2009 showed a 25% increase in new geothermal projects since August 2008 and a 35% increase in overall power production potential of new geothermal projects. The GEA report identified 126 geothermal projects under development with the potential to put 5,500 megawatts of new capacity on line. Nevada has the most production under development, with 60 projects totaling potential capacity of 1,765-3,300 megawatts, with California second with 28 projects and potential capacity of 1,050-1,350 megawatts. Many Native American tribes in California and elsewhere are also now considering geothermal power for their energy needs. In 2008, the Northwestern Band of the Shoshone Nation announced a 100-megawatt geothermal project in Northern Utah projects under development include California's Fort Bidwell Indian community, which has received Department of Energy funding. ⁷

Impact of the American Recovery and Reinvestment Act

The recently enacted federal stimulus package (the American Recovery and Reinvestment Act of 2009) is a direct and positive driver for increased geothermal energy development, through tax incentives, loan guarantees, and research and development funding. One of the keys to recent growth in the geothermal power market has been the extension of the federal production tax credit (PTC) to include new geothermal power projects in the Energy Policy Act of 2005. The PTC was first enacted in 1992 for wind projects and has demonstrated its effectiveness in providing an incentive for that industry. The PTC provides a tax credit of approximately 2.0 cents per kilowatt hour to new qualifying projects for every kilowatt hour produced in the first ten years of production.

Beginning in 2005, Congress extended the PTC for wind, geothermal, and other qualifying renewable technologies. The American Recovery and Reinvestment Act addresses this and other incentives for the geothermal power industry, including the following:

⁶ http://www.westgov.org/wga/initiatives/cdeac/Geothermal-text.pdf

⁷ For more information about some of these projects, go to http://www.eere.energy.gov/tribalenergy/projects-technology.cfm.

- A three-year extension of the PTC, making geothermal power facilities placed in service by December 31, 2013 eligible for the full credit.
- Extension of the 30% investment tax credit (ITC) to new geothermal energy projects, in some cases allowing developers to apply for a cash grant in lieu of the ITC.
- A new 30% credit for companies manufacturing renewable/geothermal power equipment.
- \$1.6 billion in new bonding authority for Clean Renewable Energy Bonds, used to finance new renewable power projects by public power, municipal, and government entities.
- Up to \$6 billion in loan guarantees for new renewable/geothermal power projects, explicitly for commercial technologies

In addition to the tax and loan incentives, the stimulus legislation provided \$400 million in new funding for the U.S. Department of Energy's (DOE) Geothermal Technologies Program to implement a wide range of research, development, demonstration, and deployment activities that will fund important and unique opportunities for the geothermal industry. This DOE program will spur new jobs in the industry, the development and deployment of new technology, and growth in new applications for the geothermal marketplace.

The DOE has announced a series of specific funding solicitations targeting key areas for near-term and long-term industry and technology advancement, including the following:

- Geothermal demonstration projects (\$140 million) Funding will support
 demonstrations of cutting-edge technologies to advance geothermal energy in new
 geographic areas, as well as geothermal energy production from oil and natural
 gas fields, geo-pressured fields, and low- to moderate-temperature geothermal
 resources.
- Enhanced geothermal systems technology research and development (\$80 million) Funding will support research of enhanced geothermal systems (EGS) technology to allow geothermal power generation across the country. Conventional geothermal energy systems must be located near easily accessible geothermal water resources, limiting its nationwide use. EGS makes use of available heat resources by technologically engineering reservoirs so they are capable of producing electricity in otherwise untappable areas. While the long-term goal of EGS is to generate cost-competitive clean electricity, enabling research and development is needed to demonstrate the technology's readiness in the near term.

• <u>Innovative exploration techniques (\$100 million)</u> – Funding will support projects that include exploration, siting, drilling, and characterization of a series of exploration wells utilizing innovative exploration techniques. Funding the exploration of geothermal energy resources can carry a high upfront risk. By investing in and validating innovative exploration technologies and methods, the Department of Energy can help reduce the level of upfront risk for the private sector, allowing for increased investment and discovery of new geothermal resources.

In total, geothermal funding to the DOE under the American Recovery and Reinvestment Act is expected to support up to 90 new projects. The DOE will select up to 20 demonstration projects to bring 20 megawatts in new applications on-line, such as oil and gas coproduction. The DOE expects to select 30 new research and demonstration projects and will support exploration at 40 projects anticipated to involve up to 400 megawatts of new capacity. All of these projects are in addition to the 126 new industry projects identified above. The DOE hopes to complete an expedited review of the numerous applications it has received under these solicitations and expects to announce decisions by late summer or early fall 2009.

Geothermal Leasing Improvements Facilitate Growth

A strong market, financial incentives, and technology and deployment support are all important measures. But with roughly half of the geothermal power production taking place on public lands, federal agency leasing and permitting activities are also important for the industry's future. There are currently 39 geothermal power plants operating on 354 federal geothermal leases.

The BLM has been moving forward with a strong program intended to support geothermal production on appropriate public lands following the enactment of changes in the federal geothermal leasing laws in the Energy Policy Act of 2005. The BLM held a competitive geothermal lease sale for 255,354 acres in California, Nevada, and Utah in Reno, Nevada earlier this year. The BLM has also completed and published a programmatic environmental impact statement (PEIS) for geothermal leasing on public lands. The plan allocates approximately 111 million acres of BLM lands and 79 million acres of National Forest System lands open for leasing. In addition, the plan allows pre-existing studies on specific lands to be used along with best management practices. The change should help reduce the processing time of future geothermal power development. Up until recently, the experience of geothermal leasing on federal lands has been difficult. Before the issuance of the PEIS, most leases were processed in 2-3 years. BLM hopes the PEIS will reduce the process to 6 months..8

Emerging Geothermal Technologies

As geothermal technology progresses, resources that were once non-commercial are now being actively examined as feasible possibilities. The following are some of the more commonly discussed areas of future development.

⁸ More information on the BLM's plan is located at http://www.blm.gov/wo/st/en/info/newsroom/2008/december/NR_12_18_2008.html

Enhanced geothermal systems (EGS) – Often categorized under the term "hot dry rock," EGS refers to any resource that requires artificial stimulation. This includes resources that have to be fully engineered or ones that produce sub-commercial hydrothermal fluid. One technique involves drilling down at least three miles. pumping water to the hot rock there to capture the heat, and then forcing the hot water back to the surface to run electric turbines. Although EGS technology is still young and many aspects remain unproven, several projects are currently underway. If EGS technology proves commercially successful, it will significantly increase the output from existing geothermal fields, as well as result in the development of geothermal energy in previously unproductive locations. In 2008, the DOE selected 21 recipients for the research, development and demonstration of EGS including a Nevada project that could lead to the first EGS plant, producing 5 MW. Subject to annual appropriations, the DOE will provide up to \$43.1 million over a four year period to the 21 awardees, some of which include universities, which should help promote innovation. With cost-share by the recipients, the public-private investments will be up to \$78 million.

Barriers to the Development and Expansion of Geothermal Resources

Geothermal investment may continue to be a challenging investment option for conventional energy industry investors due to the high cost of development and exploratory risk with long cost recovery time frames. Geothermal exploration and development is similar to the high risk profile in oil and gas exploration, but without high return potential, as geothermal profits are usually subject to more regulated electricity markets. The high upfront risk, coupled with the moderate return on investment, has detracted investment from the conventional energy industry over the years, but new policies and technology possibilities are increasing interest in geothermal once again.

One of the greatest near-term barriers to geothermal development is the scale of its power plants compared to the feasibility of development. The large resources at The Geysers, for example, have been largely developed, so geothermal power plants are becoming smaller – using technology breakthroughs to generate electricity from lower temperature resources. The small-scale plant itself is profitable and cost feasible from a per project scope, which has also made it possible for these projects to be built in time to meet the frequently-expiring federal production tax credit. However, transmission access and infrastructure build-out requirements as noted earlier pose problems regarding feasibility of scale for a long-term geothermal strategy.

EGS is expected to be the new generation of geothermal is receiving significant government funding. The current challenges of EGS regard reservoir management, connectivity and feasibility of drilling at extended depths and low permeability. As these technical challenges are being addressed, EGS will open new possibilities while at the same time magnify current constraints. EGS will attempt to improve returns by expanding the location and scalability currently limited by resource requirements. Exploration risks, however, will be magnified as EGS continues to expand the boundaries

of the current terrain by potentially drilling deeper wells, engineering subsurface reservoirs or expanding current reservoirs.

Despite increased focus and investment, the following market penetration challenges persist:

- Access to capital High risk capital requirements in the early stages of project development are a barrier for geothermal exploration.
- <u>Drilling</u> Rising drilling costs and competition with the oil and gas industry for similar talent and capital reduce the attractiveness of geothermal investment.
- <u>Leasing and permitting</u> Land lease and permit processing may not be able to keep up with demand.
- <u>Skilled labor</u> Scientists and engineers are aging and in decline while the industry demands more skilled labor than other renewable resources.
- Working fluid and water supply Working fluid prices are continuing to increase as creating possible long term feasibility issues for binary systems. EGS areas of the Western United States with potential geothermal development are susceptible to water supply shortages and constraints. Clarify what this means

At a July 2009 meeting of geothermal developers, operators, suppliers and consultants sponsored by the Geothermal Energy Association, participants listed the following factors as impediments to the development and expansion of geothermal resources (from most significant to least significant):

- Lack of financing;
- High total project costs;
- High risk of development;
- Inadequate transmission:
- Permitting delays;
- Need for better resource information;
- Federal/state policy changes;
- Drilling risks;
- Inadequate government support;
- Environmental restrictions; and
- Other.

Areas for Further Research and Development

At the July 2009 geothermal meeting, participants listed the following as the most critical areas for further research support (from most critical to least):

- Resource identification:
- More successful drilling;
- Lower cost drilling;
- Finding hidden resources;
- New exploration technology;

- Reservoir engineering techniques;
- Higher efficiency cooling systems;
- Lower temperature power production;
- Enhanced geothermal systems; and
- Higher efficiency power systems.

Geothermal Energy and Induced Seismicity

One controversial issue associated with EGS is the impact of induced seismicity, which has been the cause of delays and cancellation threats of at least two EGS projects worldwide. The oil, gas, mining, hydropower, and other extractive industries have long histories and substantial experience with seismicity due to hydrofracturing and other surface and subsurface activities. Earthquake activity, or seismicity, can be induced by human activity, including development of geothermal fields, which can result in low magnitude events known as "microearthquakes" which have Richter magnitudes below 2 or 3 and which are generally not felt by humans.

A recent New York Times article (June 24, 2009) on a microearthquake set off by EGS drilling in Basel, Switzerland has raised some concerns in California about the possibility of a similar event at The Geysers as a start-up company intends to begin drilling using the same techniques to fracture hard rock more than two miles deep to extract its heat. Residents of the region, which straddles Lake and Sonoma Counties, have already protested smaller earthquakes set off by a less geologically invasive set of energy projects there. Some seismologists believe that breaking rock that far down carries more serious risk. Because geothermal operations usually take place in areas that are also tectonically active, it is often difficult to distinguish between geothermal-induced and naturally occurring events and many regions where geothermal development has occurred or has been planned are already known as areas with high levels of fault activity. A seismic monitoring committee has been established at The Geysers to provide an open forum for concerned individuals. The environmental impact report prepared in connection with the project to bring in supplemental water from Lake County for injection at The Geysers determined that a geothermal facility would induce less than significant increases in seismic activity.

The Australian government has published a report on the risks associated with hydrofracturing. Its findings are consistent with the findings of a Lawrence Berkeley Laboratory study published in 2006, which concluded that "EGS-induced seismicity need not pose a threat to the development of geothermal energy resources if site selection is carried out properly, community issues are properly handled and operators understand the

⁹ "Induced Seismicity and Geothermal Power Development in Australia", at: www.ga.gov.au/minerals/research/national/geothermal/

underlying mechanisms causing the events." The Geothermal Energy Association's website has five new issue briefs on this topic and others¹¹.



¹⁰ See "Induced Seismicity Associated with Enhanced Geothermal Systems," Ernest L. Majer, Lawrence Berkeley National Laboratory, 2006, LBNL-LBNL-61681, at http://repositories.cdlib.org/lbnl/LBNL-128 61681/.

11 available at http://www.geo-energy.org/publications/reports.asp